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The 408 MHz all-sky survey

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The 408 MHz all-sky radio continuum survey has been a milestone of information that is still often used more than 25 years after its publication. It originated in Bonn, as did the first all-sky radio continuum survey ever published by Dröge & Priester (1956). This first all-sky survey at 200 MHz combined northern hemisphere observations with data of Allen & Gum (1950) made in Australia. The next all-sky survey of the radio emission was made by Landecker & Wielebinski (1970) who combined their southern-hemisphere Parkes radio telescope observations at 150 MHz with the 178 MHz Turtle & Baldwin (1962) data. At 408 MHz a section of the northern sky was mapped by Haslam et al. (1970) at Jodrell Bank.

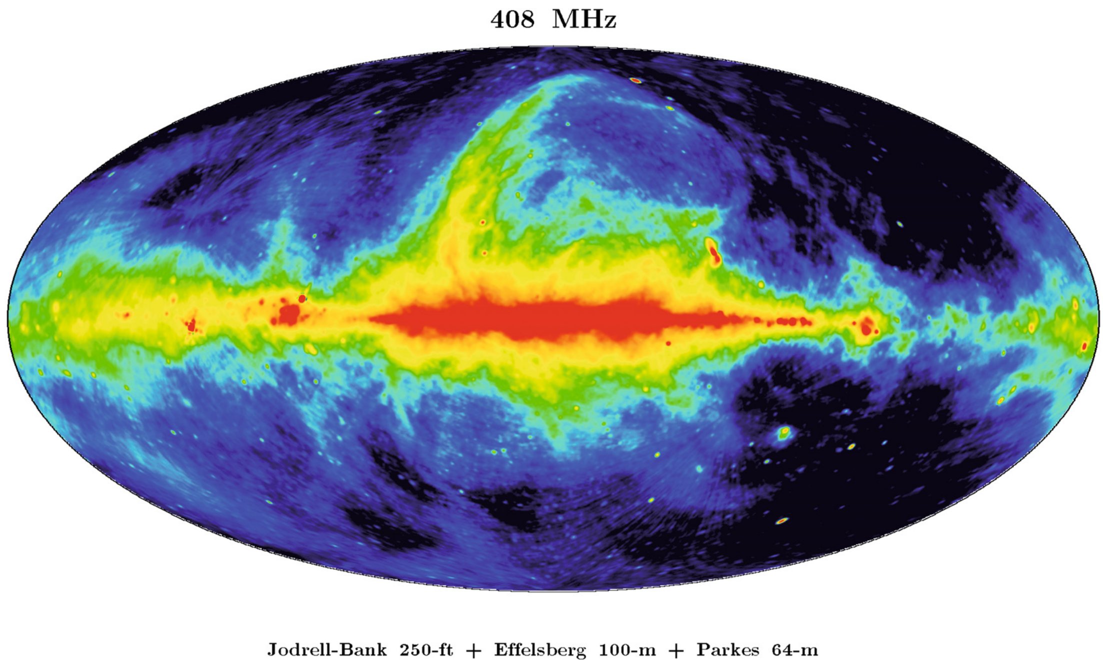
The northern hemisphere 408 MHz survey observations were made with the new 100-m radio telescope of the young Max-Planck-Institut für Radioastronomie (MPIfR). The decision to construct a large radio telescope in Germany led to founding the MPIfR in Bonn in 1965. The foundation of the institute was initiated by Prof. Dr. Otto Hachenberg, Professor of Radio Astronomy at Bonn University, who became its first Executive Director. The MPIfR was organized in three departments, each with its own director. The construction of the 100-m radio telescope started in 1968. Further directors, appointed at the institute in 1969, were Prof. Peter G. Mezger and Prof. Richard Wielebinski. The institute was generously supported by the Max-Planck-Gesellschaft, in particular with new staff. A very strong technical division was conceived to give the 100-m radio telescope the necessary support in electronics and computing. Thus the stage was set for a very active development in virtually all areas of radio astronomy. Some information about the construction of the 100-m radio telescope is found in Hachenberg (1968), Wielebinski (1970), Hachenberg et al. (1973).

The fast construction progress of the 100-m telescope required a quick staff build-up. Bonn University, which had operated the Stockert 25-m radio telescope, provided the nucleus of the new institute. In particular the research group of Hachenberg was recruited mainly from the University staff. The two new directors had to choose their staff from outside. Mezger was mainly interested in spectroscopy, and his former employer, the US National Radio Astronomy Observatory, was a natural source for recruiting his team. Wielebinski, with interests in radio continuum and pulsars, gathered staff from Australia and Jodrell Bank. Soon local Ph.D. students were incorporated into the three research groups.

The progress on the construction of the 100-m radio telescope was rapid and the main aim was to start observations at some medium high frequency, i.e. at 2.7 GHz, followed by a 10.6 GHz system. Receivers for these high frequencies were being constructed in the electronics laboratories. However, an initiative to use the telescope, already in the construction phase, led to placing a 408 MHz receiver in the primary focus of the telescope. In addition the NOD 2 software (Haslam 1974) developed for radio continuum analysis was reorganized to fit the 100-m telescope's requirements. Observations at 408 MHz started in January 1971, some of them being done in the time slots when welding work on the structure was not taking place. For the official opening of the telescope on 12 May 1971, the 408 MHz survey was running rather than a demonstration of the new drive software for the telescope. The 408 MHz observations (Haslam et al. 1974) continued until February 1972, after which the telescope was used for higher frequency work.

After the observations of the northern sky were completed, it became necessary to obtain the southern sky coverage. Negotiations with the Radiophysics Division of the CSIRO took place and a "letter of cooperation" was signed in 1972. The 408 MHz receiver and the NOD 2 software package were transferred to the Parkes radio telescope in 1973 and observations continued until March 1975. For the Parkes observations, numerous staff and students from Bonn visited Australia. A preliminary result was published by Haslam et al. (1975). On return to Bonn it became clear that the 1964-65 observations made in Jodrell Bank did not have the same quality as the rest of the survey. By that time the 100-m radio telescope was shown to work efficiently even at 24 GHz so that a return of the 408 MHz system was considered unsuitable. The receiver was taken to Jodrell Bank and the northern polar cap was observed again in 1978 (Haslam et al. 1981). The complete all-sky data were finally presented by Haslam et al. (1982) in A&AS. Considerable care was taken to ensure that the data was on an absolutely calibrated scale using published sky horn measurements.

The significance of the 408 MHz survey for astronomy can be seen in the 500+ citations, with a peak reached only a few years ago. The angular resolution of the all-sky survey of $0\overset{\circ}{.}85$ was at that time an enormous data set. The studies of the distribution of the radio emission have led to models of the Galactic emission (e.g. Phillips et al. 1981; Beuermann et al. 1985). The 408 MHz survey led to intense follow-up activity in studies of interesting regions at higher radio frequencies, with better angular resolution. Large supernova remnants, as well as large H II regions, were rewarding targets for detailed study at higher frequencies. All-sky surveys made at other radio frequencies were always compared with the 408 MHz radio data, which was a



starting point for deriving the spectral index of the radio continuum emission across the whole sky. Based on the 408 MHz observing strategy, new 1420 MHz all-sky data have been collected (Reich 1982; Reich & Reich 1986; Reich et al. 2001) to complement the all-sky radio continuum surveys, this time including full polarization data (Wolleben et al. 2006; Testori et al. 2008). In the years that followed the publication of the 408 MHz survey, all-sky surveys were also made in other spectral ranges (H I, IR, X-ray, γ-ray).

The 408 MHz survey has also been important for the predictions of the Galactic synchrotron contribution in all cosmic microwave background (CMB) studies. In fact the increase in citations in recent years comes from the subtraction of the Galactic contribution based on the 408 MHz data made for the COBE satellite mission and from all the preparatory work done for the Planck CMB satellite mission. The recent Wilkinson microwave anisotropy probe (WMAP) all-sky maps at various high frequencies (Hinshaw et al. 2007; Gold et al. 2009) match the 408 MHz data in angular resolution, thereby allowing the study of the radio spectrum over a wide frequency range and leading to improved correction of the Galactic contribution. The 1420 MHz polarization data (Wolleben et al. 2006; Testori et al. 2008) match the WMAP polarization results, which again are needed as a foreground correction in the CMB polarization studies.

The 408 MHz survey whose various renderings have reached iconic status for the MPIfR[1] and long-wavelength radio astronomy is still, more than 25 years after publication, a major data set needed for distribution of the all-sky radio continuum emission. It is an indispensible contribution to the multi-wavelength view of the Universe.

References

Allen, C. W., & Gum, C. S. 1950, Aust. J. Phys., A3, 224
Beuerman, K., Kanbach, G., & Berkhuijsen, E. M. 1985, A&A, 153, 17
Dröge, F., & Priester, W. 1856, Z. Astrophys., 40, 236
Gold, B., Bennett, C. L., Hill, R. S., et al. 2009, ApJS, 180, 265
Hachenberg, O. 1968, Beiträge Radioastron., 1, 31
Hachenberg, O., Grahl, B. H., & Wielebinski, R. 1973, Proc. IEEE, 61, 1288
Haslam, C. G. T. 1974, A&AS, 15, 333
Haslam, C. G. T., Quigley, M. J. S., & Salter, C. J. 1970, MNRAS, 147, 405
Haslam, C. G. T., Wilson, W. E., Graham, D. A., & Hunt, G. C. 1974, A&AS, 13, 369
Haslam, C. G. T., Wilson, W. E., Cooke, D., et al. 1975, Proc. ASA, 2, 331
Haslam, C. G. T., Klein, U., Salter, C. J., et al. 1981, A&A, 100, 209
Haslam, C. G. T., Salter, C. J., Stoffel, H., & Wilson, W. E. 1982, A&AS, 47, 1
Hinshaw, G., Nolta, M. R., Bennett, C. L., et al. 2007, ApJS, 170, 288
Landecker, T. L., & Wielebinski, R. 1970, Aust. J. Phys. Suppl., 12, 1
Phillips, S., Kearsey, S., Osborne, J. L., et al. 1981, A&A, 103, 405
Reich, W. 1982, A&AS, 48, 219
Reich, P., & Reich, W. 1986, A&AS, 63, 205
Reich, P., Testori, J. C., & Reich, W. 2001, A&A, 376, 861
Testori, J. C., Reich, P., & Reich, W. 2008, A&A, 484, 733
Turtle, A. J., & Baldwin, J. E. 1962, MNRAS, 124, 459
Wielebinski, R. 1970, Nature, 228, 507
Wolleben, M., Landecker, T. L., Reich, W., & Wielebinski, R. 2006, A&A, 448, 411

[1] http//:www.mpifr-bonn.mpg.de/